

CLAIMS:

1. A substantially pure protein having the amino acid sequence selected from the group consisting of: SEQ ID NO: 2, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO 14, SEQ ID NO: 16, SEQ ID NO: 18, a mutant thereof, and a
5 fragment thereof.
2. The protein of claim 1 wherein said protein has the amino acid sequence of SEQ ID NO: 2, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO 14, SEQ ID NO: 16 or SEQ ID NO: 18.
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3. An isolated nucleic acid molecule that comprises a nucleic acid sequence that encodes the protein of claim 1.
4. A recombinant expression vector comprising the nucleic acid molecule of claim 3.
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5. A host cell comprising the recombinant expression vector of claim 4.
6. An isolated nucleic acid molecule that comprises a nucleic acid sequence that encodes the protein of claim 2.
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7. A recombinant expression vector comprising the nucleic acid molecule of claim 6.
8. A host cell comprising the recombinant expression vector of claim 7.
- 25 9. An isolated nucleic acid molecule consisting of: SEQ ID NO: 1, a fragment thereof having at least 10 nucleotides, SEQ ID NO: 5, a fragment thereof having at least 10 nucleotides, nucleotides, SEQ ID NO: 7, a fragment thereof having at least 10 nucleotides, nucleotides, SEQ ID NO: 9, a fragment thereof having at least 10 nucleotides, nucleotides, SEQ ID NO: 11, a fragment thereof having at least 10 nucleotides, SEQ ID NO 13, a

ragment thereof having at least 10 nucleotides, SEQ ID NO: 15, a fragment thereof having at least 10 nucleotides, nucleotides, SEQ ID NO: 17, and a fragment thereof having at least 10 nucleotides, wherein a fragment of SEQ ID NO: 5 comprises at least 5 nucleotides of SEQ ID NO: 1.

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10. The nucleic acid molecule of claim 9 consisting of: SEQ ID NO: 1, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO 13, SEQ ID NO: 15 and SEQ ID NO: 17.

10 11. A recombinant expression vector comprising the nucleic acid molecule of claim 10.

12. A host cell comprising the recombinant expression vector of claim 11.

15 13. The nucleic acid molecule of claim 9 consisting of: a fragment of SEQ ID NO: 1 having at least 10 nucleotides, a fragment of SEQ ID NO: 5 having at least 10 nucleotides, a fragment of SEQ ID NO: 7 having at least 10 nucleotides, a fragment of SEQ ID NO: 9 having at least 10 nucleotides, a fragment of SEQ ID NO: 11 having at least 10 nucleotides, a fragment of SEQ ID NO: 13 having at least 10 nucleotides, a fragment of SEQ ID NO: 15 having at least 10 nucleotides, and a fragment of SEQ ID NO: 17 having at least 10 nucleotides, wherein a fragment of SEQ ID NO: 5 comprises at least 5 nucleotides of SEQ ID NO: 1.

25 14. The nucleic acid molecule of claim 9 consisting of a fragment of SEQ ID NO: 1 having 12-150 nucleotides, a fragment of SEQ ID NO: 5 having 12-150 nucleotides, a fragment of SEQ ID NO: 7 having 12-150 nucleotides, a fragment of SEQ ID NO: 9 having 12-150 nucleotides, a fragment of SEQ ID NO: 11 having 12-150 nucleotides, a fragment of SEQ ID NO: 13 having 12-150 nucleotides, a fragment of SEQ ID NO: 15

having 12-150 nucleotides, and a fragment of SEQ ID NO: 17 having 12-150 nucleotides, wherein a fragment of SEQ ID NO: 5 comprises at least 5 nucleotides of SEQ ID NO: 1.

15. The nucleic acid molecule of claim 9 consisting of a fragment of SEQ ID NO: 1
5 having 15-50 nucleotides, a fragment of SEQ ID NO: 5 having 15-50 nucleotides, a
fragment of SEQ ID NO: 7 having 15-50 nucleotides, a fragment of SEQ ID NO: 9 having
15-50 nucleotides, a fragment of SEQ ID NO: 11 having 15-50 nucleotides, a fragment of
SEQ ID NO: 13 having 15-50 nucleotides, a fragment of SEQ ID NO: 15 having 15-50
nucleotides, and a fragment of SEQ ID NO: 17 having 15-50 nucleotides, wherein a
10 fragment of SEQ ID NO: 5 comprises at least 5 nucleotides of SEQ ID NO: 1.

16. An isolated antibody which binds to an epitope on SEQ ID NO: 2, SEQ ID NO: 6,
SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, SEQ ID NO: 16 or
SEQ ID NO: 18, wherein an antibody that binds to SEQ ID NO: 6 does not cross react
15 with SEQ ID NO: 4.

17. The antibody of claim 16 wherein said antibody is a monoclonal antibody.

18. A method of identifying a modulator of a *lepidoptera* calcium channel protein
20 activity comprising the steps of:

performing a test assay by contacting a test cell that comprises a functional
calcium channel, wherein the test cell comprises at least one of a recombinant expression
vector that comprises a nucleotide sequence that encodes a chimeric TBW voltage-gated
calcium channel $\alpha 1$ subunit, a recombinant expression vector that comprises a nucleotide
25 sequence that encodes a TBW voltage-gated calcium channel β subunit and a recombinant
expression vector that comprises a nucleotide sequence that encodes a TBW voltage-gated
calcium channel $\alpha 2\delta$ subunit wherein said test cell expresses a functional calcium
channel, with a solution containing calcium in the presence of a test compound, and
detecting the amount of intracellular calcium in said test cell;

performing a negative control assay by contacting a negative control cell that comprises a functional calcium channel, wherein the test cell comprises at least one of a recombinant expression vector that comprises a nucleotide sequence that encodes a chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit, a recombinant expression vector
5 that comprises a nucleotide sequence that encodes a TBW voltage-gated calcium channel β subunit and a recombinant expression vector that comprises a nucleotide sequence that encodes a TBW voltage-gated calcium channel $\alpha 2\delta$ subunit and wherein said negative control cell expresses a functional calcium channel, with a solution containing calcium in the absence of said test compound, and detecting the amount of intracellular calcium in
10 said negative control cell;

comparing the amount of intracellular calcium in said test cell to the amount of intracellular calcium in said negative control cell

wherein a change in the amount of calcium in said test cell compared to the amount of intracellular calcium in said negative control cell indicates the test compound is a
15 modulator of calcium channel activity.

19. The method of claim 18 wherein the test cell is a *Xenopus* oocyte cell, a CHO cell or an HEK cell.

20. The method of claim 18 wherein the intracellular calcium is detected by using an assay in which fluorescence generated by dye inside of said cell interacting with intracellular calcium is measured.

21. The method of claim 18 further comprising performing a positive control assay by
25 contacting a positive control cell which comprises a functional calcium channel, with a solution containing calcium in the absence of said test compound and in the presence of a calcium channel agonist, and detecting the amount of intracellular calcium in said positive control cell.

22. The method of claim 21 wherein the calcium channel is a *lepidoptera* calcium channel.

23. The method of claim 18 further comprising the step of

5 performing a second-type negative control assay by contacting a negative control cell that does not express a functional calcium channel with a solution containing calcium in the absence of said test compound, and detecting the amount of calcium taken up by said calcium channel negative control cell; and/or

10 performing a third-type negative control assay by contacting a negative control cell that does not express a functional calcium channel with a solution containing calcium in the absence of said test compound and in the presence of a calcium channel agonist, and detecting the amount of calcium taken up by said calcium channel negative control cell.

15 24. The method of claim 23 wherein the calcium channel is a *lepidoptera* calcium channel.

25. The method of claim 18 wherein said functional calcium channel comprises at least one of: a chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit, a TBW voltage-gated calcium channel β subunit and a TBW voltage-gated calcium channel $\alpha 2\delta$ subunit, 20 wherein the chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit comprises SEQ ID NO: 2, a mutant thereof, and a fragment thereof; the TBW voltage-gated calcium channel β subunit comprises SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, a mutant thereof, and a fragment thereof and the TBW voltage-gated calcium channel $\alpha 2\delta$ subunit comprises SEQ ID NO: 16, SEQ ID NO: 18, a mutant thereof, and a fragment thereof.

25 26. The method of claim 25 wherein the test cell is a *Xenopus* oocyte cell, a CHO cell or HEK cell.

27. The method of claim 25 wherein the intracellular calcium is detected by using an assay in which fluorescence generated by dye inside of said cell interacting with intracellular calcium is measured.

5 28. The method of claim 25 wherein said functional calcium channel comprises a chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit that comprises SEQ ID NO: 2; a TBW voltage-gated calcium channel β subunit that comprises SEQ ID NO: 8, SEQ ID NO: 10 or SEQ ID NO: 12 and a TBW voltage-gated calcium channel $\alpha 2\delta$ subunit comprises SEQ ID NO: 16 or SEQ ID NO: 18.

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29 The method of claims 28 wherein that chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit comprises SEQ ID NO: 6.

15 30. The method of claim 28 wherein the nucleic acid sequence that encodes the chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit that comprises SEQ ID NO: 1; the nucleic acid sequence that encodes the TBW voltage-gated calcium channel β subunit comprises SEQ ID NO: 7, SEQ ID NO: 9 or SEQ ID NO: 11; and the nucleic acid sequence that encodes the TBW voltage-gated calcium channel $\alpha 2\delta$ subunit comprises SEQ ID NO: 15 or SEQ ID NO: 17.

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31. The method of claim 30 wherein the nucleic acid sequence that encodes the chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit that comprises SEQ ID NO: 5.

25 32. A method of identifying an inhibitor of a *lepidoptera* calcium channel protein activity comprising the steps of:

performing a test assay by contacting a test cell that comprises a functional calcium channel, wherein the test cell comprises at least one of a recombinant expression vector that comprises a nucleotide sequence that encodes a chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit, a recombinant expression vector that comprises a nucleotide

sequence that encodes a TBW voltage-gated calcium channel β subunit and a recombinant expression vector that comprises a nucleotide sequence that encodes a TBW voltage-gated calcium channel $\alpha 2\delta$ subunit and wherein said test cell expresses a functional calcium channel, with a solution containing calcium and a calcium channel agonist in the presence
5 of a test compound, and detecting the amount of intracellular calcium in said test cell;

performing a control assay by contacting a negative control cell that comprises a functional calcium channel, wherein said negative control cell expresses a functional calcium channel, with a solution containing calcium and a calcium channel agonist in the absence of said test compound, and detecting the amount of intracellular calcium in said
10 negative control cell;

comparing the amount of intracellular calcium in said test cell to the amount of intracellular calcium in said control cell

wherein a decrease in the amount of intracellular calcium in said test cell compared to the amount of intracellular calcium in said control cell indicates the test compound is an
15 inhibitor of calcium channel activity.

33. The method of claim 32 wherein the test cell is a *Xenopus* oocyte, a CHO cell or an HEK cell.

20 34. The method of claim 32 wherein the intracellular calcium is detected by using an assay in which fluorescence generated by dye inside of said cell interacting with intracellular calcium is measured.

25 35. The method of claim 38 wherein said functional calcium channel comprises at least one of a chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit that comprises SEQ ID NO: 2, a mutant thereof, and a fragment thereof; a TBW voltage-gated calcium channel β subunit that comprises SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, a mutant thereof, or a fragment thereof and the TBW voltage-gated calcium channel $\alpha 2\delta$ subunit that comprises SEQ ID NO: 16, SEQ ID NO: 18, a mutant thereof, or a fragment thereof.

36. The method of claim 35 wherein the test cell is a *Xenopus* oocyte, a CHO cell or an HEK cell.
- 5 37. The method of claim 35 wherein the intracellular calcium is detected by using an assay in which fluorescence generated by dye inside of said cell interacting with intracellular calcium is measured.
- 10 38. The method of claim 35 wherein said functional calcium channel comprises a chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit that comprises SEQ ID NO: 2; a TBW voltage-gated calcium channel β subunit that comprises SEQ ID NO: 8, SEQ ID NO: 10 or SEQ ID NO: 12; and a TBW voltage-gated calcium channel $\alpha 2\delta$ subunit comprises SEQ ID NO: 16 or SEQ ID NO: 18.
- 15 39. The method of claims 38 wherein that chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit comprises SEQ ID NO: 6.
- 20 40. The method of claim 38 wherein the nucleic acid sequence that encodes the chimeric TBW voltage-gated calcium channel $\alpha 1$ subunit that comprises SEQ ID NO: 1; the nucleic acid sequence that encodes the TBW voltage-gated calcium channel β subunit comprises SEQ ID NO: 7, SEQ ID NO: 9 or SEQ ID NO: 11 and the nucleic acid sequence that encodes the TBW voltage-gated calcium channel $\alpha 2\delta$ subunit comprises SEQ ID NO: 15 or SEQ ID NO: 17.
- 25 41. A method of preparing an isolated protein having the amino acid sequence selected from the group consisting of SEQ ID NO: 2, a mutant thereof, and a fragment thereof; SEQ ID NO: 6, a mutant thereof, a fragment thereof, SEQ ID NO: 8, a mutant thereof, a fragment thereof, SEQ ID NO: 10, a mutant thereof, a fragment thereof, SEQ ID NO: 12, a mutant thereof, a fragment thereof, SEQ ID NO: 16, a mutant thereof, a fragment thereof

SEQ ID NO: 18, a mutant thereof, and a fragment comprising the step of isolating said protein from a host cell of claim 5.

42. A method of controlling an insect, comprising contacting an insect with a
5 modulator identified by a method according to claim 18.

43. A method of controlling an insect, comprising contacting an insect with an inhibitor identified by a method according to claim 32.

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